Sub-Saharan African Cities:

Five-City Network to Pioneer Climate Adaptation through Participatory Research and Local Action

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***Abstract:**
This project addresses knowledge, resource, capacity and networking gaps on the theme: 'Strengthening urban governments in planning adaptation.'
The main objective of this project is to develop an adaptation framework for managing the increased risk to African local government and their communities due to climate change impact. The ultimate beneficiaries of this project will be African local governments and their communities. The guiding and well-tested ICLEI principle of locally designed and owned projects for the global common good, specifically in a developing world context, will be applied throughout project design, inception and delivery.

Additionally, the research will test the theory that the most vulnerable living and working in different geographical, climatic and ecosystem zones will be impacted differently and as such, will require a different set of actions to be taken. Potential commonalities will be sought towards regional participatory learning and wider applicability. The five urban centres chosen for this study, based on selection criteria, include: Cape Town, South Africa, Dar es Salaam, Tanzania; Maputo, Mozambique; Windhoek, Namibia; and Port St. Louis, Mauritius.

Through a participatory process, this project will carry out a desk-top study, long-term, multi-discipline, multi-sectoral stakeholder platforms in five Southern African cities comprising of academics, communities and the local government in order to facilitate knowledge-sharing, promote proactive climate adaptation and resource opportunities available for African cities, develop five tailor-made Adaptation Frameworks and explore regional applicability. A network of stakeholders within each urban centre will be established, feeding into a larger regional network of local authorities and partners in Sub-Saharan Africa, and globally through existing ICLEI global (e.g. the ICLEI Cities for Climate Protection programme), ICLEI Africa and UCLG-A members and networks, ensuring global best practice, roll-out, and long-term sustainability.

Key words: Adaptation, Africa, Climate Change, Local Governments, Participatory Action Research, Policy.

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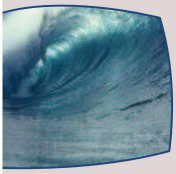
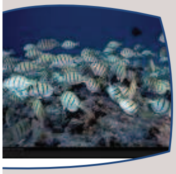
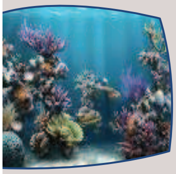

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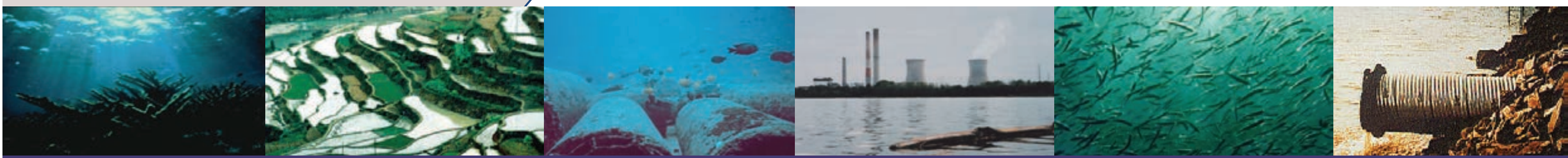

GLOBAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES
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Blue Diamonds—Oceans and Coasts is a quarterly newsletter to raise awareness among stakeholders of issues and activities relating to the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA–Marine). The Secretariat for GPA-Marine is hosted by the UNEP Marine and Coastal Ecosystems Branch of the Division of Environmental Policy Implementation (DEPI) together with the Marine Ecosystems Unit and the Regional Seas Programme. Stakeholder Forum edits and produces Blue Diamonds.

An Ocean of Change

David Osborn
Coordinator, GPA Marine

In July 2009 I was invited to write a feature article for Climate-L.org, the on-line service provided by International Institute for Sustainable Development. I titled the article "Copenhagen - An Ocean of Change" and contended that climate change "is a prevailing wind through which all other issues – economic, social and environmental – must be navigated." I suggested that "the importance of building the resilience of coastal and marine ecosystems to the impacts of climate change cannot be overstated and that the Copenhagen negotiators "must recognize that significant and rapid investment, coupled with improved cooperative action, is urgently needed to:

1. Better understand the role of coastal and oceanic systems in mitigating climate change;
2. Build the resilience of coastal and oceanic ecosystems to climate change by:

- Improving coastal and ocean water quality;
- Ensuring adequate and representative protection of coastal and ocean habitats;
- Limiting the spread of introduced marine pests;
- Adopting ecosystem-based approaches to the management of coastal and marine industries, including fisheries; and
- Enhancing the capacity of coastal communities and marine industries to adapt to climate change.

I concluded with the statement "Governments must go to Copenhagen prepared to turn the tide, not just ride the waves of change." I will leave it to others to determine the extent to which the tide was turned in Copenhagen, but the urgency to better understand and protect coastal and marine ecosystems has only increased in the post-Copenhagen world. This edition of Blue Diamonds, the newsletter of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, focuses on this very important issue. It highlights the need to build and maintain resilience in coastal and marine systems through comprehensive, continuing and adaptive action at multiple scales. I extend my warm appreciation to each of the authors who have contributed to this edition.

Assessing Resilience

Jerker Tamelander, Manager, Oceans and Climate Change,
UCN Global Marine Programme

In spite of the risks associated with climate change, ecosystems and people are capable of recovery from climate-related damage. Resilience can be understood as the ability of an ecological or social system to cope with changes and shocks, maintaining and/or restoring functional processes when disturbed. The utility of the resilience concept for ecosystem management is in its focus on assessing vulnerability and risks of the system to nurture a system's ability to cope with change and to recover from impacts. Being a systems concept, it can be applied within a variety of systems. Because of our dependence on ecosystem goods and services the improvement of ecological resilience can also enhance socioeconomic resilience.

"Resilience assessment provides a model on how to cope with pressures and change, such as recovery from climate-related damage."

In 2006 the International Union for the Conservation of Nature (IUCN) established Working Group on Climate Change and Coral Reefs (CCCR) to improve and expand our understanding of coral reef resilience and bridge the gaps between theoretical science and practical management applications.

"Resilience demonstrates that there are positive actions we can take to counter potentially devastating impacts of climate-related coral bleaching."

Healthy Coral Reef © J Tamelander IUCN

Coral reefs contain 25% of known oceans species, while only covering 0.2% of its floor. (Roberts, 2003), and provide global benefits valued as high as USD 172 billion per annum. However, they are also highly vulnerable to anthropogenic disturbances, and one of the first ecosystems with global distribution to show world-wide decline as a result of climate change. An estimated 19% of the original area of coral reefs worldwide has by now been destroyed, another 15% are seriously threatened with loss within the next 10 to 20 years and a further 20% are under threat of loss in 20 to 40 years. (Wilkinson, 2008). This makes them a canary in the coalmine for climate change, but also useful as a model ecosystem for developing and testing resilience-based management and adaptation planning.

However, in order to support management or policy decision-making resilience must be measurable. This requires defining critical processes, identifying drivers of resilience along multiple dimensions (e.g. drivers that maintain/ strengthen resilience vs. those that undermine/weaken the system, or 'slow' vs. 'fast' drivers), and how these act on critical ecosystem constituents and processes (Obura and Grimsditch, 2009). The reef resilience assessment methodology developed through CCCR (Obura and Grimsditsch (eds) 2009) focuses on three major constituents of the reef system, corals, algae and fish/consumer functional groups. It identifies the ecological interactions that drive dynamics within and among these three constituents; habitat and environmental influences; and external drivers, including anthropogenic and climate factors.

Assessments carried out by IUCN and CCCR partners in the Pacific, Indian Ocean and Caribbean have contributed both towards the development of the reef resilience assessment methodology and to supporting management of reefs in the face of climate change. Broadening this framework to also include socioeconomic variables will enable more comprehensive planning responses, such as supporting ecosystem-based adaptation. This is currently being taken forward by CCCR.

Bleached Coral Reef © Paul Marshall

Resilience assessment provides a model learning on how to cope with pressures and change. Resilience demonstrates that there are positive actions we can take to counter potentially devastating impacts of climate-related coral bleaching as well as other climate change effects. It provides a means to anticipate impacts and take steps to prevent crossing critical thresholds. Integration of resilience into marine management, such as Marine Protected Areas (MPA) and spatial planning, can improve ecosystem health and associated livelihoods in the face of climate change. It thus has the potential to support social resilience, climate adaptation and sustainable development.

For further information on Coral Reef Resilience Assessment please see: www.iucn.org/cccr

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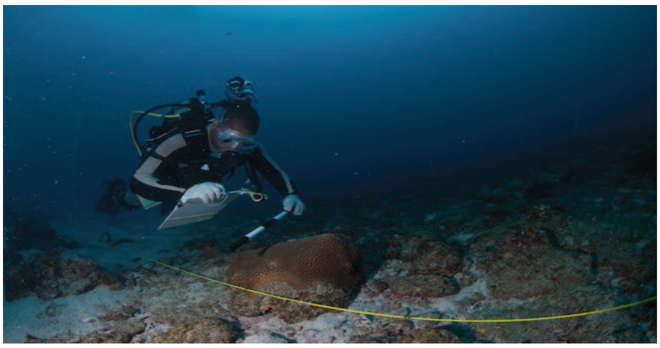

CSI EAF 09 © J Tamelander IUCN

Sick Water

GPA Marine would like to draw your attention to the launch of the new UNEP and UN-Habitat Rapid Response Assessment on wastewater: launched on World Water Day, 22 March 2010, "Sick water? The central role of wastewater management in sustainable development" not only identifies the threats to human and ecological health and the consequences of inaction, but also presents opportunities, where appropriate policy and management responses over the short and longer term can trigger employment, support livelihoods, boost public and ecosystem health and contribute to more intelligent water management. This was a collaborative effort with the UN Secretary General's Advisory Board on Water and Sanitation (UNSGAB), in partnership with the members of UN Water to bring together our collective experience and expertise to bear on the challenges posed by illegal and unregulated wastewater.

We chose to launch it on World Water Day given this years theme: Clean Water for a Healthy World. The next issue of this newsletter will focus on this topic and the outcomes of the Global Event in Nairobi 20-22 March. To view and download the report please use the following link:
http://www.unwater.org/downloads/SickWater_unep_unh.pdf

GPA Survey

The GPA in collaboration with Stakeholder Forum will be conducting a stakeholder consultation on 'perceptions of the GPA', seeking feedback through a survey from a diversity of governmental and non-governmental stakeholders who engage with the GPA on how the GPA can best meet stakeholder needs.

For more information please contact Hannah Stoddart at Stakeholder Forum –
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Coral reef resilience – policies for coastal zone management to enhance resilience

David Obura, CORDIO East Africa

Coral reefs and their associated habitats (seagrass beds and mangrove forests) are located in a highly vulnerable location, in tropical coastal zones where more than 500 million people worldwide depend on them for food, storm protection, jobs, and recreation. Their resources and services are worth an estimated 375 billion dollars each year. On recent estimates, 70% of the worlds' coral reefs are threatened or destroyed, 20% of those are damaged beyond repair (Wilkinson 2004), and the rate of degradation is accelerating (Bruno and Selig 2007). Damage to reefs is from a variety of sources, including direct extraction (e.g. from fishing) and damage (e.g. from construction, landfill, shipping, etc), and indirect effects of habitat alteration (e.g. from river flow, runoff and pollution). In addition, climate change is now recognized as one of the greatest threats to coral reefs worldwide (Hoegh-Gulberg et al. 2008, Veron et al. 2009). Mass coral bleaching caused by rising sea temperatures has already impacted reefs worldwide (16% of reefs suffered lasting damage in 1998 alone), while acidification from rising CO_2 levels will fundamentally alter the biochemistry of corals, weakening their skeletons and reef frameworks.

"70% of the worlds' coral reefs are threatened or destroyed, 20% of those are damaged beyond repair"

"Climate change is now recognized as one of the greatest threats to coral reefs worldwide. "

The natural resilience of reefs, that maintains them in a coral-dominated state, is being undermined by these combined stresses, that often act in synergy. Resilience is a useful concept in coral reef management, as it enables managers and policy makers to consider many disparate influences on reefs under a common framework (fig. 2). Threats to a reef system may come from a variety of sources both internal and external. An example of the former is imbalance between biotic components (such as between corals and algae, or algae and fish, or corals and the microbial community). Examples of the latter are climate change, fishing, or coastal development. These all act in different and highly specific ways – but resilience concepts enable us to look at how they cause imbalance in the coral reef community, and compare their importance in any particular case study.

Two general properties determine the resilience, or ability of coral communities to persist in the face of rising temperatures: their sensitivity and their recovery potential. Sensitivity relates to the ability of individual corals to experience exposure to a stress (e.g. high temperature, or pollution) without bleaching (a stress response), and if they bleach to survive. Recovery potential relates to the community's capacity to maintain or recover its structure and function in spite of coral mortality (Nystrom and Folke 2001, McClanahan et al. 2002, West and Salm 2003, Obura 2005).

Land-based activities generally impact on coral reefs through alteration of water quality and general habitat characteristics. This can fundamentally affect both the sensitivity and recovery ability of corals:

Sensitivity – pollutants and eutrophication from sewage require corals to expend energy on homeostasis. This can reduce the amount of energy available for combating rising temperatures, making them more susceptible to bleaching and mortality. Further, once stressed by these factors, the bleaching/mortality thresholds of individual corals will be reduced. In both cases, corals affected by land-based pollutants will be more vulnerable to

Figure 1. Fore reef slope at Mouadzaza, south of Moroni on Grande Comore in March 2010. The Crown-of-Thorns seastar (foreground, Acanthaster planci) have killed all the table corals (float plates in the mid-ground) among the primary reef and habitat-builders in the region, which were regrowing after mass mortality of corals in 1998.

increased seawater temperatures, and may die earlier than unstressed corals.

Recovery ability – the recovery and regrowth of corals is strongly influenced by the ability of coral larvae to settle on reef surfaces, and of young corals to compete against algae and the microbial community present in reef waters, sediments and on algal surfaces.

Eutrophication promotes the growth of microbes and fast-growing algae over corals, enabling them to outcompete corals. This prevents both the successful settlement of new corals, and their survival and growth to larger size classes. It can be seen frequently that in areas affected by reduced water quality, healthy mature reefs can persist.

But once a major mortality occurs, such as from high seawater temperatures, early life stags of corals cannot establish themselves and successfully compete, and the reef is unable to return to a coral-dominated state.

Best-practice guidelines for coral reef management using resilience principles have been developed by a number of organizations and partnerships (see reference materials, below), and they can be described for a case-study reef, such as the one pictured near Moroni, in the Comoro Islands. Resilience-based management combines the best of detailed/local interventions such as are done in Marine Protected Areas, and landscape-level interventions such as are done in coastal zone management.

The resilience of this reef has been undermined by: a) mass mortality of corals in 1998 caused by synergies between global warming and ocean-basin phenomena such as the El Niño-Southern Oscillation; b) increasing liquid and solid waste and pollution from the town of Moroni and surrounding villages, resulting in declining water quality and enhancement of the algal and microbial community; c) heavy fishing, as the reef is immediately adjacent to a fishing village and landing point; and d) outbreak of the coral-eating starfish the Crown-of-Thorns, whose early life-history survival is enhanced under conditions of eutrophication. Resilience-based management would address each of these problems – pollution and waste-water management, fisheries management and pest eradication for the last three. Just one of these would be good as an intervention, but combining all three would best restore the recovery potential of the reef. The global warming signal can only be changed by improved carbon and energy policies in the major global economies – the US, China, EU, India, Russia and Brazil. Nevertheless, action on the first three will increase the ability of the reef to cope with climate change, in the hope that action on carbon/energy policies will happen fast enough to prevent the worst effects of climate change.

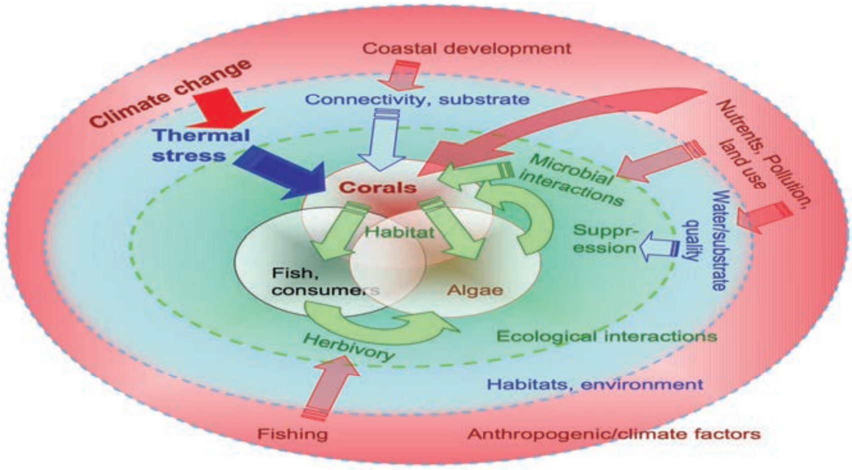

Figure 1. Resilience concepts help frame analysis of the many different factors affecting coral reef health. The inner (green) circle represents the main ecological sub-components of the reef and ecological interactions, the middle (blue) circle represents the broader reef environment, including physical characteristics such as temperature, substrate and ocean currents/connectivity, and the outer (red) circle represents external pressures such as from people an dclimate change. Key interactions and pathways are highlighted.

Resources

IUCN resilience publications http://www.iucn.org/cccr/publications

Reef Managers Guide to Bleaching (Marshall and Schuttenberg 2006) download from IUCN, GBRMPA and NOAA websites.

Reef Resilience Partnership http://www.reefresilience.org/

Healthy Reefs http://www.healthyreefs.org/

Resilience Alliance http://www.resalliance.org

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Ecosystem-based adaptation: increasing resilience in coastal areas

Imen Melaine, International Marine Policy Advisor, The Nature Conservancy

Adaptation to climate change is a new and pressing problem for human societies, and often adaptation strategies to climate change have focused on engineering structures, technological solutions, and economic diversification. Currently, there is a growing body of examples and evidence that adaptation strategies based on natural resources, or ecosystem-based adaptation, can play an important role in climate change adaptation.

In the development of ecosystem-based adaptation strategies, resilience has been a key principle. Resilience is the ability of a system to undergo, absorb, and respond to change and disturbance, while maintaining its functions. Conservation and restoration have demonstrated effective strategies that build and improve the resilience of ecosystems which in turn contribute and help sustain communities' livelihoods, providing them with ingredients to increase their societal adaptation to climate change impacts. Such strategies are particularly important for the poorest communities which depend most on nature and which are amongst the most severely affected and thus the most vulnerable to climate change impacts.

> ***"Resilience has been a key principle in the development of ecosystem-based adaptation strategies."***

Building resilience into natural habitats requires an understanding of how these will respond to climate changes, what factors help them survive these changes, and, consequently, how to manage them to increase their survival chances. The application of resilience principles as an adaptation strategy has been most advanced in coral reef ecosystems. Corals reefs are already experiencing climate-related impacts such as bleaching by warming ocean temperatures and the growing issue of ocean acidification. Some coral reefs are able to withstand these stresses to a greater degree (are more resistant) while other coral reefs are able to recover from bleaching events more rapidly (are more resilient) depending on oceanographic, ecological and physiological factors.

Experience has shown that management to maintain healthy reefs by reducing local stresses, such as overfishing and pollution increases their resistance to climate change. In addition, establishing and maintaining a network of well-managed and connected protected areas where environmental conditions appear to boost resistance and resilience to bleaching events (i.e. reef areas that are naturally resistant to coral bleaching (resistant areas), and reef areas where environmental conditions are likely to promote maximum recovery after bleaching mortality has occurred (resilient areas)) offers greater resilience or ability to recover from climate change impacts to the entire reef system. Reef resilience management approaches will become increasingly critical in supporting the survival of reefs and the communities that depend on them. A healthy reef provides people with a buffer from waves and storm surge, feeds coastal communities dependent on the sea for protein and livelihoods, and sustains tourism economies.

Although these principles were developed to address coral reefs and increases in sea temperature, similar principles of resilience can be applied to other ecosystems. MPA networks can maintain natural connections across seascapes so that ecosystems can continue to function and to provide services to dependent communities.

In partnership with the Lauru Land Conference of Tribal Communities, TNC worked with local communities in the Choiseul province of the Solomon Islands to help plan local coastal land and resource Management in response to climate impacts.. © Cathy Siota

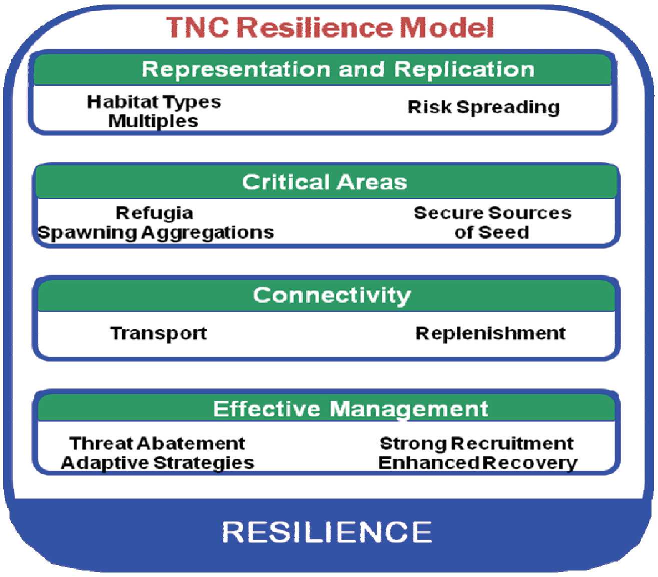
On the coast, Sea level rise is one of the major impacts of climate change. It is causing gradual inundation of lowlands, increased rates of erosion, salinization of ground-water and increased frequency and intensity of storm events with significant impacts from storm surges. These impacts, coupled with accelerated development activities, and even some planned adaptation responses to climate change that are focused on using "hard" engineering solutions, are putting shorelines and coastal communities are at further risk as their natural buffers, such as coastal wetlands, mangroves and dunes, are lost.

Certain coastal ecosystems offer important coastal protection services by providing a powerful buffer during extreme storm events, greatly mitigating storm surge and flood impacts and reducing costs of recovery in adjacent lands. There are also numerous examples of the important role that eco-systems such as shellfish reefs, coral reefs, mangroves and wetlands, play in dissipating wave energy, and trapping and holding coastal sediments. Such invaluable services come at a much lower cost than engineered solutions, and bring a multitude of other ecosystem benefits -that may otherwise be lost with grey infrastructure- such as maintaining or improving food security and livelihoods and contributing to local economies.

> ***"To be successful in a changing world, adaptation strategies should strive to achieve the complementary key goals of maintaining biodiversity, promoting ecosystem values, and enhancing resilience."***

By maintaining ecosystem productivity and supporting and sustaining income-generating activities in the face of climate change, ecosystem-based strategies provide a basis for social adaptation. In Kimbe Bay, Papua New Guinea, coral reef resilience principles were applied to design a network of marine protected areas to help the Bay's ecosystems withstand the impacts of a warming ocean and continue to provide food and other resources to local communities. In Samoa, mangroves are being planted as part of a larger restoration project to enhance food security and protect local communities from storm surges, which are expected to increase as a result of climate change. Such activities not only help maintaining the natural ecosystem s and the contribution of their services to local, regional, and national economies.

To be successful in a changing world, adaptation strategies should strive to achieve the complementary key goals of maintaining biodiversity, promoting ecosystem values, and enhancing resilience. Planning for adaptation can be challenging in situations in which there is much uncertainty and disagreement about how best to manage the potential consequences of climate change, yet there is a need to take anticipatory adaptive action. Along with NOAA and NASA, the Conservancy developed a decision-support tool, *Coastal Resilience*, to help stakeholders on Long Island understand sea level rise and coastal storms, visualize the likely impacts and risks, and identify management options that diminish losses to natural and human coastal communities. We are working to translate such activities in data-poor environments where local communities often don't have access to and understanding of information on climate change that will impact their lives. Engagement of stakeholders is key in the development of adaptation strategies; it provides opportunities for vulnerable coastal communities to employ local knowledge and participates directly in developing and applying adaptive solutions and policies. It also helps in building a constituency for the management responses, agreeing upon and understanding the consequences of the decisions made.



www.reefresilience.org - Reef Resilience toolkit with guides to building resilience into coral reef ecosystems
www.coastalresilience.org - an interactive and user-friendly Web mapping tool designed to help inform the coastal management decision-making process.

Scientific Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity

Nicola Barnard, Senior Programme Officer, UNEP-WCMC

On behalf of the Secretariat of the Convention on Biological Diversity (CBD), the UNEP World Conservation Monitoring Centre has conducted a major study to synthesise the observed and predicted impacts of ocean acidification on marine biodiversity reported in more than 300 publications from the scientific literature. The study describes a range of scenarios of the possible ecological impacts of ocean acidification for marine ecosystems. It was released by the CBD on the 14th December 2009 to mark Oceans Day during the climate change negotiations in Copenhagen.

> ***"The absorption of atmospheric CO_2 changes the chemical balance of the oceans, causing them to become more acidic"***

According to the study, seas and oceans absorb approximately one quarter of the carbon dioxide emitted to the atmosphere from the burning of fossil fuels, deforestation, and other human activities. As more and more carbon dioxide (CO_2) has been emitted into the atmosphere, the oceans have absorbed greater amounts at increasingly rapid rates. Without this level of absorption by the oceans, atmospheric CO_2 levels would be significantly higher than at present and the effects of global climate change would be more pronounced.

> ***"Basic functioning and critical life support services that ocean ecosystems provide will be different under future acidified oceans"***

However, the absorption of atmospheric CO_2 changes the chemical balance of the oceans, causing them to become more acidic, and reducing the availability of carbonate minerals. It is predicted that by 2050, ocean acidity could increase by 150%. This increase is 100 times faster than any change in acidity experienced in the marine environment over the last 20 million years and gives little time for evolutionary adaptation within biological systems; calling into question the future structure, health, and stability, of marine ecosystems.

> ***"Increasing oceanic concentrations of CO_2 influence the physiology, development and survival of marine organisms."***

The global oceans have historically been super saturated with carbonate minerals, which are critical compounds for many marine animals and plants to use in the formation of skeletons and shells. As the world's oceans become less saturated with carbonate minerals over time, calcifying marine organisms are expected to build weaker skeletons and shells, and experience slower growth rates. Given current CO_2 emission rates, it is predicted that the surface waters of the highly productive Arctic Ocean will become undersaturated with respect to essential carbonate minerals by the year 2032, and the Southern Ocean by 2050 with disruptions to large components of the marine food web. For example, the decline of calcifying pteropod densities, a key food for fish, is expected to influence the predator-prey relationships of many species (e.g. Cod, Pollock) and could result in greater predation pressure on juvenile fish, such as commercially important salmon.

The chemical changes that result from ocean acidification may also compound each other. As seawater becomes more acidic, it becomes corrosive. This means that the shells of calcifying organisms, which are already weaker due to reduced availability of carbonate ions, are increasingly prone to dissolution. Predictions indicate that by 2100, 70% of cold-water coral reef habitats, key refuges and feeding grounds for commercially important fish species, will be exposed to corrosive waters. Large areas of the tropical oceans will also experience rapid declines in carbonate ions causing coral reef growth to slow, and ultimately be outpaced by bio-erosion and sea-level rise. These changes are likely to have profound impacts on the ability of these ecosystems to continue to provide critical ecosystem goods and services (e.g. food security and coastal protection, collectively valued at an estimated

US$29.8 billion per year globally) to millions of the world's poorest people.

Emerging research suggests that many of the effects of ocean acidification on marine organisms and ecosystems will be variable and complex, impacting developmental and adult phases differently across species depending on genetics, pre-adaptive mechanisms, and synergistic environmental factors. Evidence from naturally acidified locations indicates that although some species may benefit (e.g. seagrasses), biological communities under acidified seawater conditions are typically less diverse, and lacking calcifying species.

Many questions remain regarding the biological and biogeochemical consequences of ocean acidification for marine biodiversity and ecosystems, and the impacts of these changes on oceanic ecosystems and the services they provide, for example, in fisheries, coastal protection, tourism, carbon sequestration and climate regulation. The ecological effects must be considered alongside other environmental changes associated with global climate change (e.g. increasing temperature, sea level rise) and the impacts of human activities on ocean ecosystems, and how these impacts interact with increasing ocean acidification to affect the health and function of marine ecosystems.

"There are no short term solutions to ocean acidification. Substantial perturbations to ocean ecosystems can only be avoided by urgent and rapid reductions in global emissions of CO_2"

Ocean acidification is an observed and predictable consequence of increasing atmospheric CO_2 concentrations that is occurring independently of climate change. Despite the uncertainties, it is clear that the basic functioning and critical life support services that ocean ecosystems provide will be different under future acidified oceans as increasing oceanic concentrations of CO_2 influence the physiology, development and survival of marine organisms. There are no short term solutions to ocean acidification, which is only reversible on timeframes of at least tens of thousands of years. Substantial perturbations to ocean ecosystems can only be avoided by urgent and rapid reductions in global emissions of CO_2, and the recognition and integration of this critical issue into the global climate change debate.

Bubbles from the CO_2 vent field at Ischia. © Hall-Spencer et al. (2008)

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Blue Carbon and the GPA

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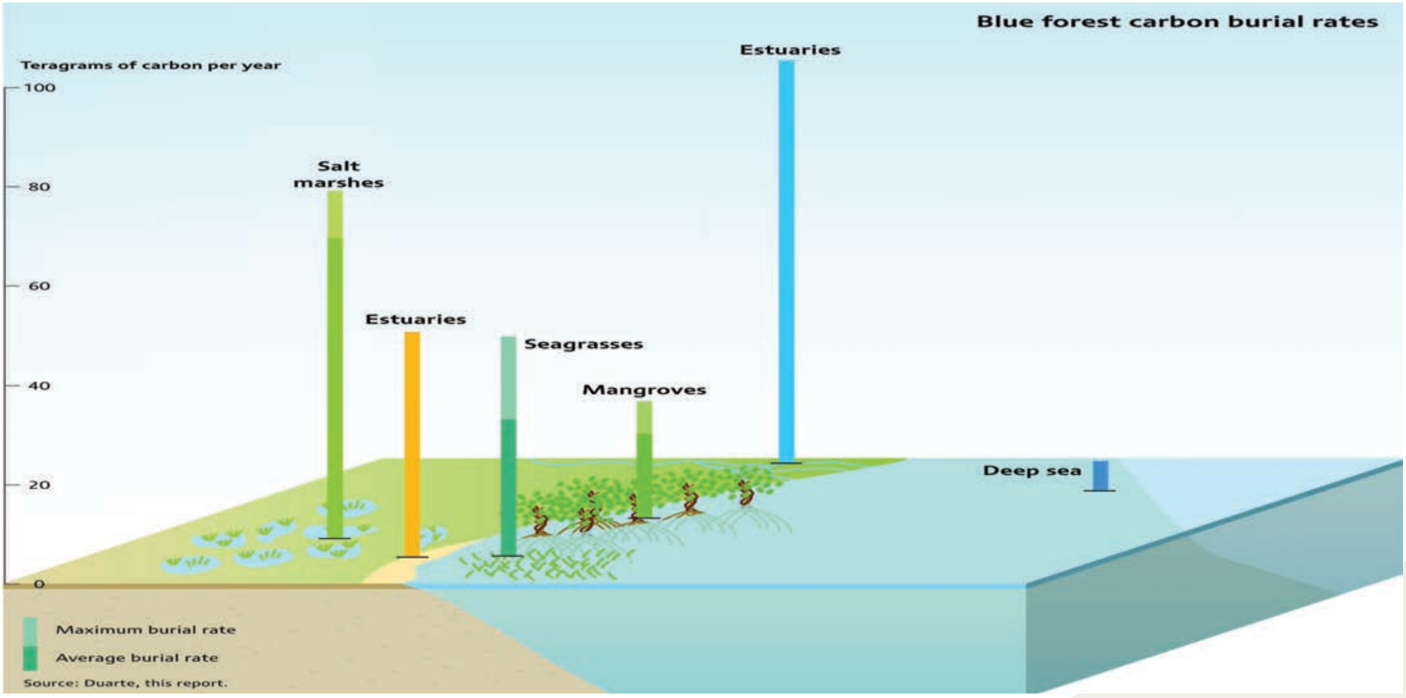
Blue Carbon, i.e. the carbon stored and sequestered by our oceans and coasts, is entering the climate debate in a big way. Oceans and coasts play a crucial role in our climate as well as our economy, yet their role in carbon sequestration has to a large extent been overlooked in international climate change mitigation protocols. Blue Carbon gives the international community the chance to address this failing, and the potential is impressive.

According to a recent UNEP report (Nellemann et al, 2009), of all the carbon captured by living organisms globally, 55% is captured by marine and coastal organisms. Of this carbon sequestered in the marine environment, between 50 and 71% is stored in coastal vegetated habitats such as mangroves, saltmarshes and seagrasses. That is 235-450 Teragrams of carbon per year, or the equivalent of 3-7% of total anthropogenic fossil fuel emissions. Furthermore, Blue Carbon sinks also help impoverished coastal communities adapt to the threats of climate change by providing coastal protection, food security and water storage. Protecting these carbon sinks should thus be a vital part of the global climate change strategy. In response to this need, UNEP and partners are working to better understand and quantify Blue Carbon, with the prospect of getting Blue Carbon credits onto the global carbon market.

"Ocean and Coastal ecosystems are being lost at an incredibly rapid rate, as much as 7% annually, and most could be lost within two decade"

However, the report notes that these ecosystems are being lost at an incredibly rapid rate, as much as 7% annually, and most could be lost within two decades. The main reasons blamed in the UNEP report are unsustainable resource use practices, poor watershed management, poor coastal development practices and poor waste management. Threats are not always marine-based, and poor water quality resulting from land-based activities is a major reason for the degradation of Blue Carbon sinks. Losing these ecosystems not only erodes their natural capacity for carbon sequestration, but also affects human health, food security and economic development



Blue forest carbon sinking burial rates © Cebrian and Duarte, 1996; Duarte et al., 2005.

in the coastal zone.

This is where the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) comes into play as an excellent tool for protecting Blue Carbon ecosystems. This multilateral framework encourages governments to put the policies in place that will protect coastal ecosystems from threats upstream; reducing stress from nutrients and sedimentation while enhancing water quality. In order for the GPA to be effective, institutional, policy and economic reforms are urgently needed at the national and sub-national levels. If these reforms can be made and the GPA can be successfully implemented, then we can better protect our Blue Carbon assets that are so valuable for regulating our climate through carbon sequestration, protecting our coasts from storms and erosion, and providing food security and livelihoods for hundreds of millions of people around the world.

"The GPA is an excellent tool for protecting Blue Carbon ecosystems"

For further information on Blue Carbon please see:
www.grida.no/publications/rr/blue-carbon/

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Coastal areas: An overview of governance systems in southern Africa.

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Coasts are some of the most impacted and altered on the globe. They are dynamic systems that are constantly undergoing adjustments in form and process at different temporal and spatial scales in response to topographical and physical factors such as, oceanography, geomorphology and human development. The coastal marine and terrestrial interface is amongst the most socially and economically vital on the planet. At the global level, the human population is estimated to be around 6.8 billion (USCB, 2010), of this, around 60% of the world's population lives within 60km of the sea. These coastal nodes of development are experiencing growth in the human population due to natural growth and migration. This increase in the number of people living near the coast and the human activities occurring along the coast, has resulted in an imbalance that is overshadowing and destroying the much needed natural resources and aesthetics that made these places attractive in the first place.

In conjunction with these environmental changes, the evidence that climate change is happening and will continue to do so is now overwhelming. International opinion is that climate change will manifested itself through various changes in climatic variables, such as changes in temperature, rainfall and precipitation patterns, sea level rise and extreme events (IPCC, 2007). In present day conditions and in addition, by the end of the next decade, storm surges are projected to increase in frequency and intensity. This will unquestionably influence coastal systems in numerous ways. Firstly, in increasing erosion rates and soil damage and secondly by increasing salinity. The impacts will depend upon each ecosystems ability to sustain themselves during these events and the amount of time that is required to replenish themselves after such an event (although this is anticipated to become shorter) (Brundrit, 2009). With a focus on Namibia, South Africa and Mozambique, an analysis of current international obligations on coastal protection is beyond the scope of this article, it could be noted however that affective integrated coastal zone management is not a one country effort. The protection of coastal integrity should be undertaken with concerted effort by neighbouring countries. Political frontiers have no bearing on ecosystems which are only limited by their biophysical carrying capacity.

For the purposes of this article, the authors intend to provide a broad overview of the existing governance systems pertaining to coastal zone management, identifying a number of gaps, conflicting mandates and activities relating to current coastal management from the national, regional and local government levels, with a view to the potential for implementing effective adaptation strategies to climate change such as Integrated Coastal Zone Management (ICZM).

Main themes that policy-makers should strive to attain are: stakeholder participation, cross-sectoral and institutional integration leading toward, and encouraging, long term sustainability.

The concept of ICZM emerged in 1992 at the UN Earth Summit in Rio de Janeiro, and is set out in Chapter 17 of Agenda 21. It is an holistic approach in its consideration of the impacts on the integrity of the ecosystem. The main themes that policy-makers should strive to attain are: stakeholder participation, cross-sectoral and institutional integration leading toward, and encouraging, long term sustainability. All of which are also applicable when considering measures for effective adaptation to the impacts related to climate change such as sea level rise and sea storm surges.

The aforementioned three countries to be discussed are constitutional democracies with three-tier systems of government namely, the national (including national line ministries), regional/provincial and local authorities/municipalities, each of which are mutually dependent, distinct and interconnected (For more information, visit: http://www.decentralisation.gov.na (for Namibia),www.southafrica.info (for South Africa), www.undp.org.mz (Mozambique)). The interactions between them are incumbent upon effective ICZM and adaptive capacity. These must be considered in combination with a number of other barriers, such as: institutional/legal, informational/educational, financial, technological and social/cultural for increasing sustainability and environmental integrity at the local level.

The southern African coastline is covered by protected areas, mining concessions, ports and development for domestic purposes. Historically and presently, there are a number of areas of concern to be found in coastal management strategies ranging from legislation to stakeholder participation (or the lack thereof) and including; institutional frameworks, planning, human capacity and education of coastal areas. From a **legislative perspective**, problems are evident at all levels of the policy-making process, from enactment to implementation, monitoring and enforcement and to varying degrees within each of the aforementioned countries. At the enactment stage, certain key biodiversity hotspots within these southern African countries are not afforded legal protection (i.e. the Walvis Bay wetland, subject to heavy human and industrial activities) and even when legislation is enacted, it is often fraught with inadequacies such as laws, carrying penalties that are not adequate deterrents in the present day. With regard to enforcement, there appears to be a very poor record of compliance within environmental standards and often, areas of the coast in these countries are in difficult to reach places or completely inaccessible, making monitoring and enforcement very difficult.

Poor inter and intra coordination and integration often results in the coastal environment being perceived as a sectoral

Figure 1. The sea storm surge image - against the sea point promenade - September 2008. The force of the waves associated with a sea storm surge impacting on the sea point promenade in Cape Town. © Darryl Colenbrander (City of Cape Town)

Figure 2 . Kelp cleaning - South of the Diep River Mouth.. Poverty alleviation program in Cape Town aimed to provide job opportunities, protection to the coast and community understanding and well being. © Darryl Colenbrander (City of Cape Town)

issue, and not an overarching consideration in policy formulation. Responsibilities tend to be unclear and centralised which often overshadows the importance of tailoring policies to the geographical, topographical and bathymetric characteristics of the region. Local authorities are often more apt to engage with environmental protection since they have the knowledge of the carrying capacity of their coastline. The insufficient horizontal and vertical integration between different levels and sectors of governance is of serious concern for the effective implementation of ICZM and adaptation strategies.

However, given these adversities, local governments in each of these Southern African countries are striving to overcome these issues through putting actions into place and on the ground. Local governments such as Walvis Bay (Namibia), Cape Town (South Africa) and Maputo (Mozambique) are each prioritising coastal zones as issues that they have come to realise are integral to sustainability and their future survival, given future climatic projections. Examples can be seen in the movement toward understanding and modelling of the behaviour of storm surges and freshwater flooding by each of the cities, given the current impacts that are already being witnessed (Cape Town). Figure 1 depicts the force of the waves associated with a sea storm surge impacting on the sea point promenade in Cape Town South Africa (Fig. 1). This will inevitably have a role in temporal and fiscal dedication toward the development of coastal monitoring programs and active rehabilitation of natural ecosystem based protection. Figure 2 depicts one of the numerous poverty alleviation programs, undertaken by local community based organisations in partnership with the City of Cape Town, that are currently being undertaken whereby, the goals and actions undertaken, serve to provide job opportunities, protection to the coast and community understanding and wellbeing (Fig. 2).

About Stakeholder Forum

Stakeholder Forum is an international organisation working to advance sustainable development and promote democracy at a global level.

To this end, we work with a diversity of stakeholders globally on international policy development, media and communications, advocacy, lobbying, consultation and evaluation to promote progressive outcomes on sustainable development through an open and participatory approach

www.stakeholderforum.org

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